
Meridian 1

Companion Microcellular

Overview

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The cellular concept

Originally, mobile service structure was similar to television broadcasting. One very powerful transmitter located at the highest spot in an area would broadcast in a radius of up to 25 miles. While this allowed users to make and receive telephone calls using a mobile phone, they had limited service capabilities and poor service performance. In addition, this structure did not use the available radio spectrum efficiently.

The “cellular concept” structured the mobile telephone network in a very different way. Instead of using one powerful transmitter, a cellular service provider placed many low-power transmitters throughout a coverage area. For example, by dividing a metropolitan region into 100 different areas (cells) with low-power transmitters using 12 channels each, the cellular service provider could increase system capacity from 12 channels (one powerful transmitter) to 1,200 channels (100 low-power transmitters).

While this approach of dividing regions into smaller cells improved the capacity of the system and improved the efficiency of its utilization of the cellular spectrum, mobile units using the same channel in adjacent areas interfered with each other. Thus, it was evident that all channels could not be reused in every cell. However, the same channel could be used again in a nonadjacent cell. This concept of frequency reuse has since been refined, but it is still the basic frequency allocation technique used in all cellular networks today.

Frequency reuse plan

The frequency reuse plan of a cellular system (often called the frequency plan) describes how radio channels are to be allocated to cells to minimize interference problems and to ensure that users in different cells can use the same frequency channel simultaneously. The available channels are divided into groups, with the individual members of the groups being separated widely enough to prevent interference within the group. The groups are then assigned to a number of different cells throughout the network such that the same set of channels is not reused in adjacent cells.

The frequency reuse distance depends on the geographical contour, antenna height, transmit power and number of co-channel cells in the vicinity of the center cell, among other things. Mathematically, the frequency reuse distance is a function of the radius (coverage) of the cell.

Co-channel interference between cells (interference due to the common use of the same channel) defines the reuse of a given frequency channel in different cells.

When the number of subscribers approaches the maximum that a cell can support, the original cell can be split into smaller cells. Thus, cell splitting allows an increase in the potential number of subscribers without an increase in bandwidth. These smaller cells can be split further once they reach their maximum traffic density. Typically, one cell is split into four smaller cells. Economic and practical considerations are the key factors in the decision to split a cell: the cost of additional network infrastructure has to be balanced by an increase in subscriber revenue. Typically, the smallest cells have a radius of about 1km in urban areas and about 15km in rural areas.

Handoff

The final obstacle in the development of the cellular network involved the problem created when a mobile telephone user traveled from one area to another during a call. Since adjacent areas do not use the same radio channels, a call must be either dropped or transferred from one radio channel to another when a mobile telephone crosses the line between areas. Dropping the call was obviously not an acceptable solution, so the process of handoff, or handover, was created. In handoff, the mobile telephone network automatically transfers the call from radio channel to radio channel as a mobile unit crosses adjacent cells, allowing the call in progress to continue.

Roaming

Roaming allows the cellular user the use of cellular service in a 'visited' system. A cellular user is typically identified by the Mobile Identification Number (MIN) and the Electronic Serial Number (ESN). This information is stored in the Home Location Register (HLR). Information related to visiting users is temporarily stored in a Visitor Location Register (VLR).

Cellular system architecture

In modern cellular networks, rural and urban regions are divided into areas according to specific provisioning guidelines. Deployment parameters, such as the amount of cell splitting and cell sizes, are determined by engineers experienced in cellular system architecture. Radio channels for each region are reused according to plans developed by the cellular service provider.

Cell

The term cellular comes from the name given to the areas into which a coverage region is divided. These areas are called cells. Cells are typically represented with a hexagonal shape. In reality, cells are likely to have an irregular shape.

Cellular service area

The geographic area within which the cellular system licensee is required to provide reliable service as a condition of the license granted by the Federal Communications Commission (FCC).

Cellular system components

The cellular system delivers telephone services to portable users throughout its coverage area. The system has the capacity to serve tens of thousands of subscribers in a major metropolitan area. The cellular communications system consists of the following three major components, which work together to provide mobile service to subscribers:

- Mobile switching centers
- Cell site with antenna system
- Mobile subscriber unit (portable)

Mobile switching centers

A mobile switching center (MSC) functions like the central office in the regular telephone network, providing the switching and control functions between cell sites and between multiple mobile switching centers in the cellular service provider's network. The mobile switching centers are connected to the Public Switched Telephone Network (PSTN). Mobile calls are routed over the PSTN to and from the mobile switching centers. Each cell site is connected to an MSC via high-speed data links and dedicated voice-grade circuits.

Cell site

The term cell site refers to the physical location of radio equipment that provides coverage within a cell. Hardware located at a cell site includes the following equipment:

- Power sources
- Radio frequency transmitters and receivers
- Antenna systems

Power sources

Power sources supply the equipment at the cell sites with the energy necessary for proper operation. For example, urban cell sites use AC electrical power with battery backup systems, while some rural areas might use generators with battery backup systems.

Radio frequency transmitters and receivers

The radio frequency (RF) transmitters convert the information signal into a form suitable for transmission. Antenna(s) receive the signal, which is then translated into a more meaningful form by the receiver.

Antenna systems

Antenna systems are responsible for signal transmission and reception of radio waves. The type of antenna system depends on the characteristics of the intended coverage area.

Mobile subscriber units

A mobile subscriber unit (MSU) consists of a control unit and a transceiver that transmits and receives radio transmissions to and from a cell site. The following types of MSUs are available:

- Mobile telephone (maximum transmit power 4.0 watts)
- Transportable telephone (maximum transmit power 1.6 watts)
- Portable telephone (maximum transmit power 0.6 watts)

A mobile telephone is installed in the trunk of a car, and the headset is installed in a location convenient to the driver. Portable and transportable telephones are hand-held and can be used anywhere. The use of a portable or transportable telephone is limited to the charge life of its internal battery.

Channels

A channel consists of two frequency channel bandwidths, one for transmitting radio signals and one for receiving them. A cellular system has two types of channels: control channels and voice channels.

Control channels

Control channels perform a number of key functions. First, control channels are responsible for regularly paging the mobile units to keep track of their locations so that calls can be delivered. Once a portable is located, the control channel ensures that the portable is registered on the system. Then the control channel assigns a voice channel to the mobile unit so that the call can be completed. Control channels also provide ringing and other required signaling to the portable.

Voice channels

A voice channel is used to transmit voice. Once a call is established, the voice channel is in use for the duration of the call.

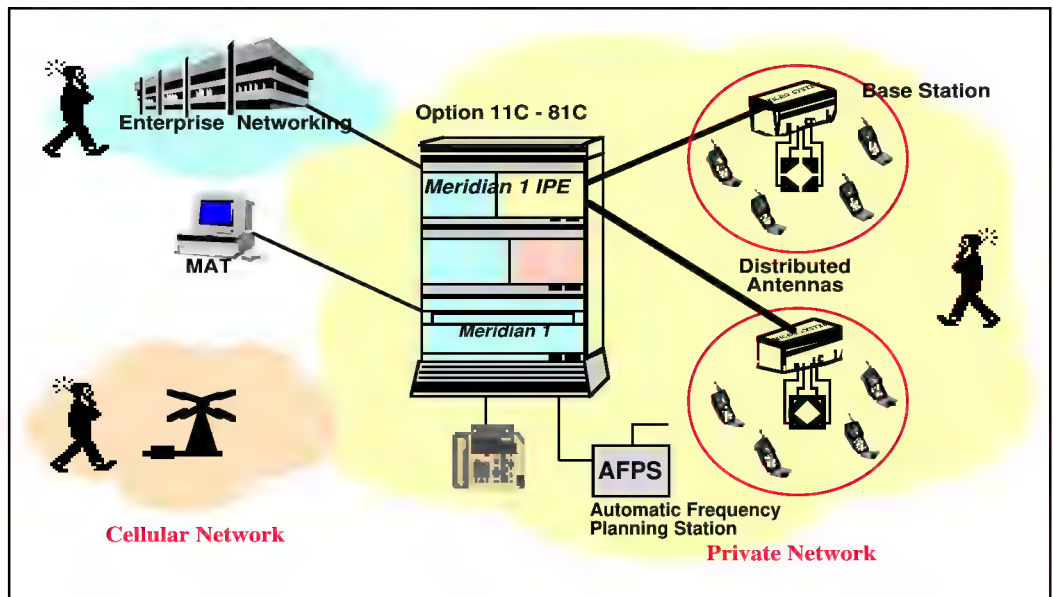
The microcell concept

A microcellular system allows the cellular spectrum provided by a licensed cellular service provider to be used within a private domain by placing low-power base stations, antennas, and other equipment on the customer's site. This customizable architecture enables creation of a very small cell, a microcell, that only registered users can access while on the customer's site. Because the cellular service provider owns the license to the frequency channels that the microcell will use, the carrier must provide the channels that are used within the microcell.

Companion Microcellular product overview

The Nortel COMPANION Microcellular provides users both in-building and wide area mobility using a single standard cellular portable. Within the Microcell coverage area (in-building), the Microcellular system delivers wireless communications and popular Meridian 1 features—including CLID, Message Waiting Indication, transfer, and conference—to the cellular portable user.

Figure 1
In-building and wide-area wireless communications using a single, standard cellular portable



The Microcellular product is fully integrated with the Meridian 1 PBX. It is supported on Options 11C, 51C, 61C, 81, and 81C running X11 Release 23 or later software. (See Figures 2, 3, and 4). Two Intelligent Peripheral Equipment (IPE) cards, the Embedded Intelligent Mobility Controller (EIMC) and the Microcellular Transcoder Card (MXC), are required for the operation of the Microcellular system. The EIMC is the wireless controller while the MXC provides voice transcoding functions and interfaces with the base stations via standard twisted pair wiring. Operations, administration, and maintenance (OA&M) are provided via the Meridian Administration Tool (MAT) Release 5.7 or later.

The system's radios are located within a Microcellular Base Station (MBS) station, which can be located in an equipment closet up to 3,000 feet from the Meridian 1 system. Antennas are distributed throughout the premises and connected to each MBS via coaxial cable. Automatic Frequency Planning (AFP) provides the ability for the Microcellular System to determine which frequencies it may use within the 800 MHz cellular band. This is achieved by continuous monitoring of the surrounding radio frequency environment. AFP helps the cellular operator maintain the microcell frequency plan to prevent interference with the macrocellular system and to maintain signal quality for the Microcellular system.

Companion Microcellular supports Enhanced Full Rate Codec¹ (EFRC) thereby enhancing the intrinsic voice quality of the system. EFRC can provide near wireline voice quality and represents a significant voice quality improvement over the current Vector Sum Excited Linear Predictive (VSELP) technology. Industry Standard IS-136 compatible portables with EFRC functionality must be used with the Companion Microcellular system for EFRC service. A Microcellular system can support EFRC or VSELP portables or a mixed VSELP/EFRC user population

1. Sometimes referred to as Algebraic Code Excited Linear Predictive (ACELP)

The Microcellular product reuses the standard 800 MHz public cellular spectrum to provide wireless communications inside the customer's buildings. Because the cellular spectrum is licensed to regional cellular service providers by the Federal Communications Commission (FCC), the cellular channels used by the Microcellular system must be obtained from a cellular operator. Generally, no cellular air-time charges apply to calls made from within the Microcellular system's coverage area; instead, a flat monthly fee might be charged for each user of the in-building service. When outside the Microcellular system's coverage area, users can make and receive calls throughout the macrocellular network with the same cellular portable. In most cases, standard cellular rate plans apply to calls made over the macrocellular network.

Microcellular system configuration

A Microcellular system configuration can be tailored for each customer. The following figures illustrate some configuration options.

With the Microcellular product, users also have personal mobility across multiple Meridian 1 systems within an enterprise network. With the Multi-Site Networking option, users can move between Meridian 1 systems connected in a private ISDN network and make and receive calls on their portables. When a user turns on a portable at a “visited” site, a Meridian 1 system automatically provides service to that user and forwards calls directed to the user's “home” directory number (DN) to the portable. Unanswered calls receive the user's preferred call treatment (for example, forward to Meridian Mail on the home switch).

An IS-136 cellular portable owner who is a registered microcell user can be reached when a second user dials a single number. The call will be delivered to the first party at any location.

Microcellular works in Carrier Remote-IPE and Multi-IPE Fiber Remote configurations. A Microcellular system can also be used as an adjunct behind SL-1, SL-100, and most other PBXs. (See Figure 5)

Figure 2
Microcellular system (Options 51C, 61C, 81, or 81C)
with TCM connection to AFP Station

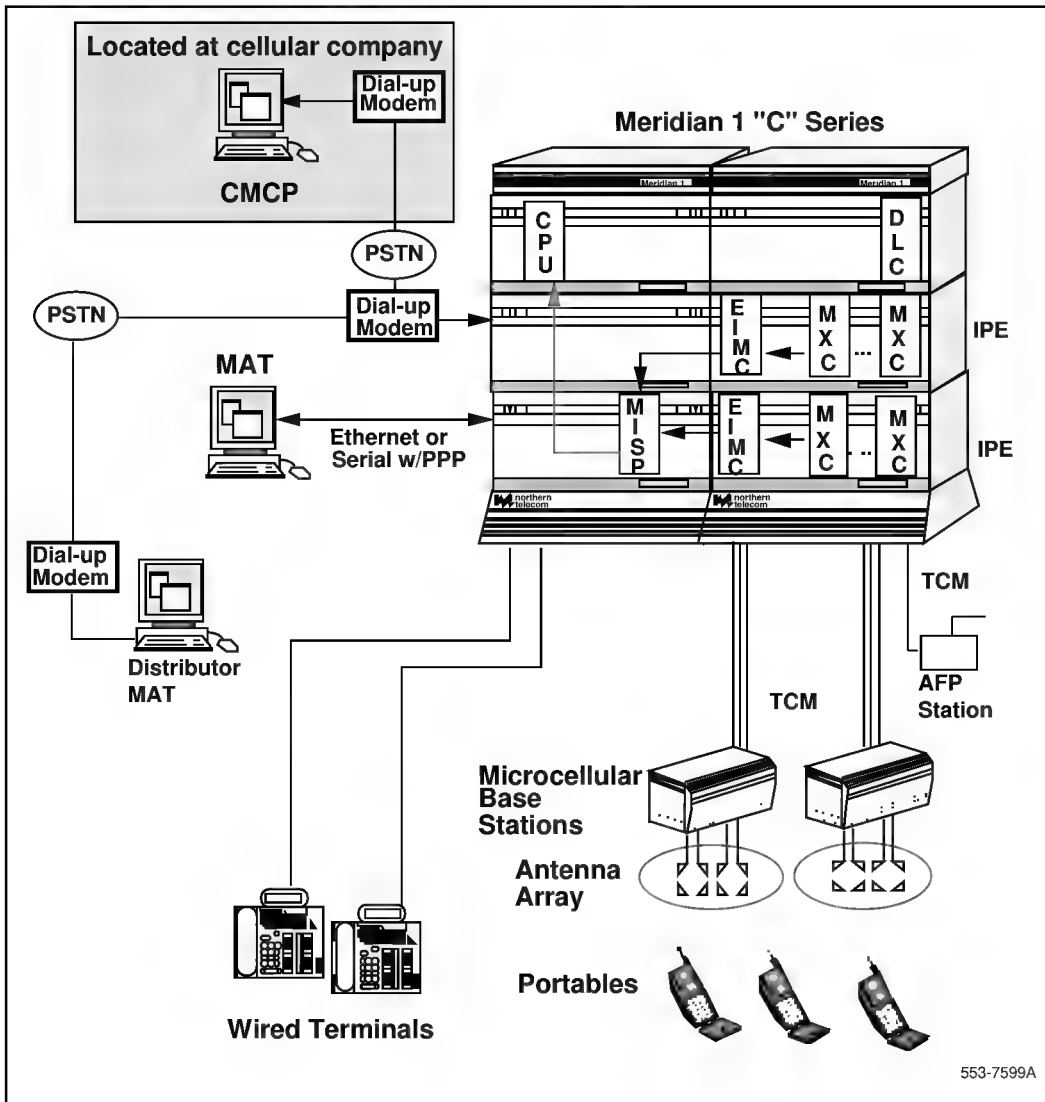


Figure 3
Microcellular system with serial connection to AFP Station

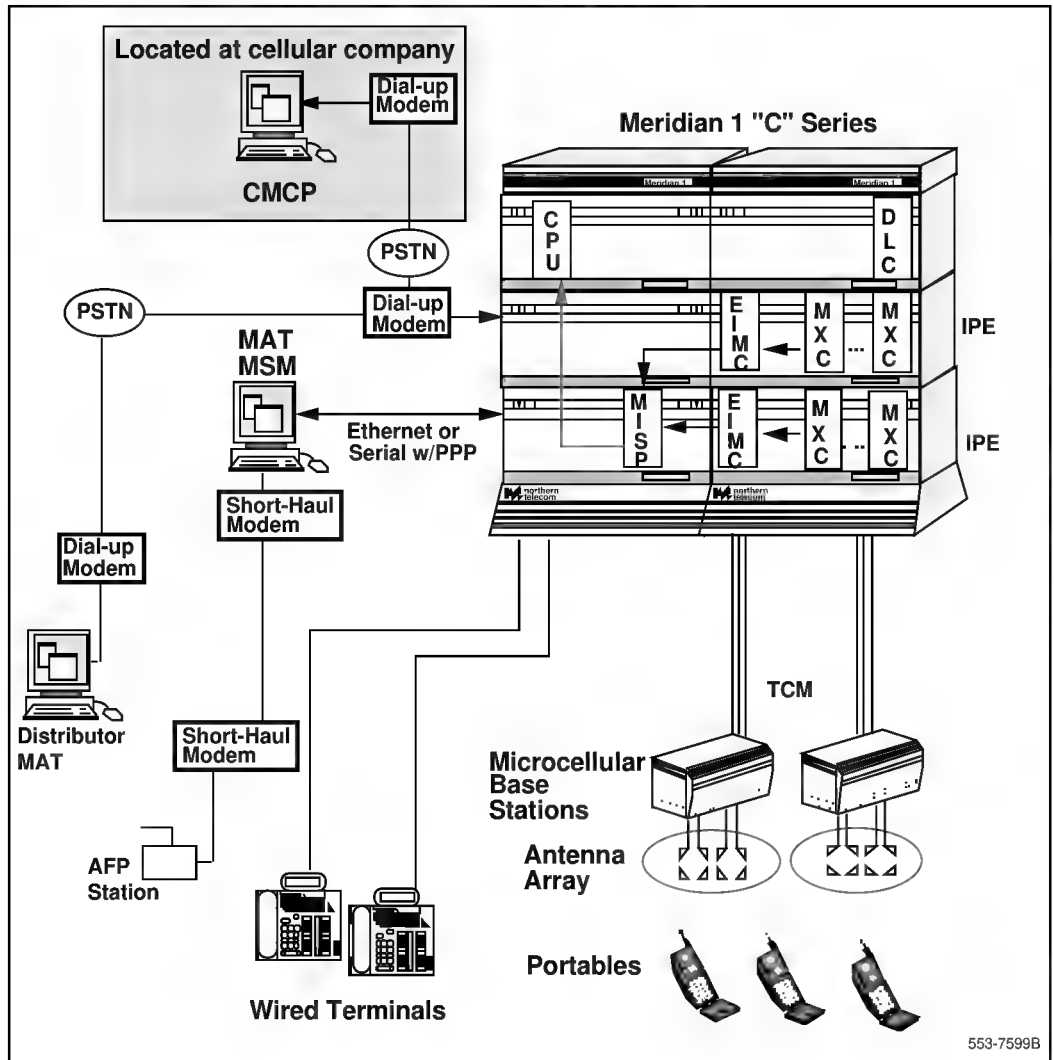


Figure 4
Microcellular system configuration (Option 11C)

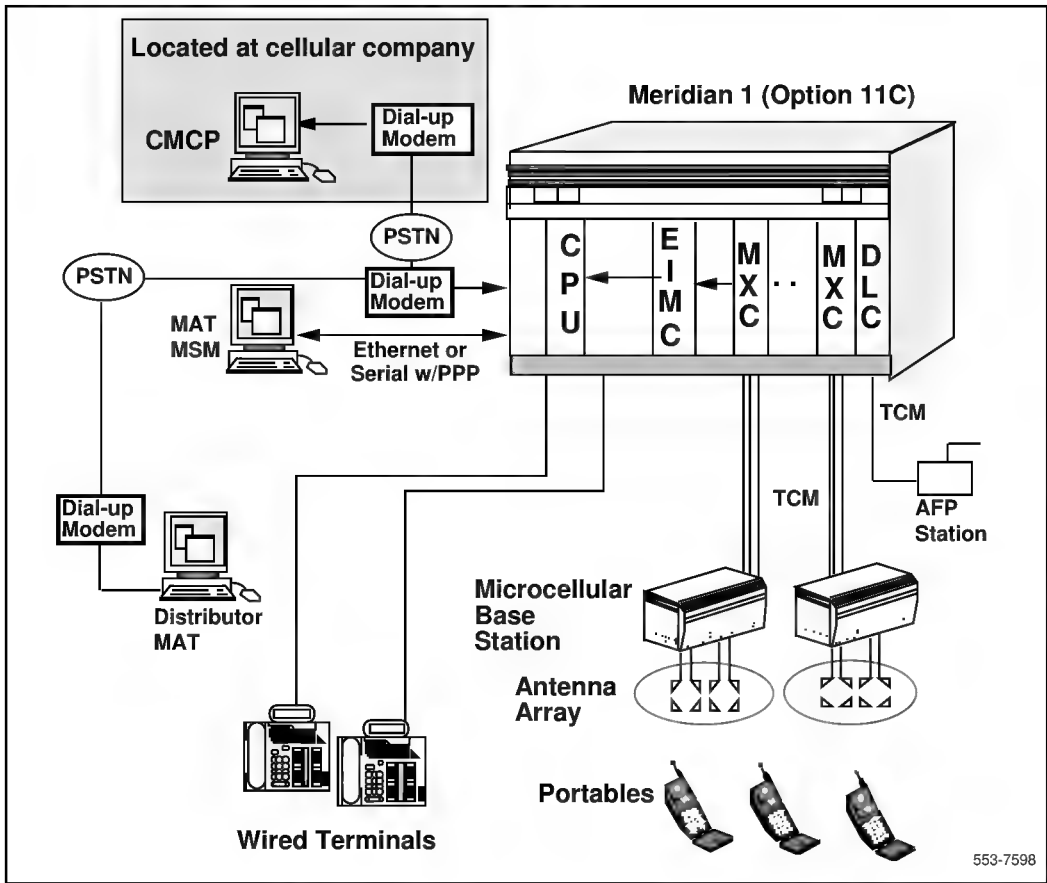
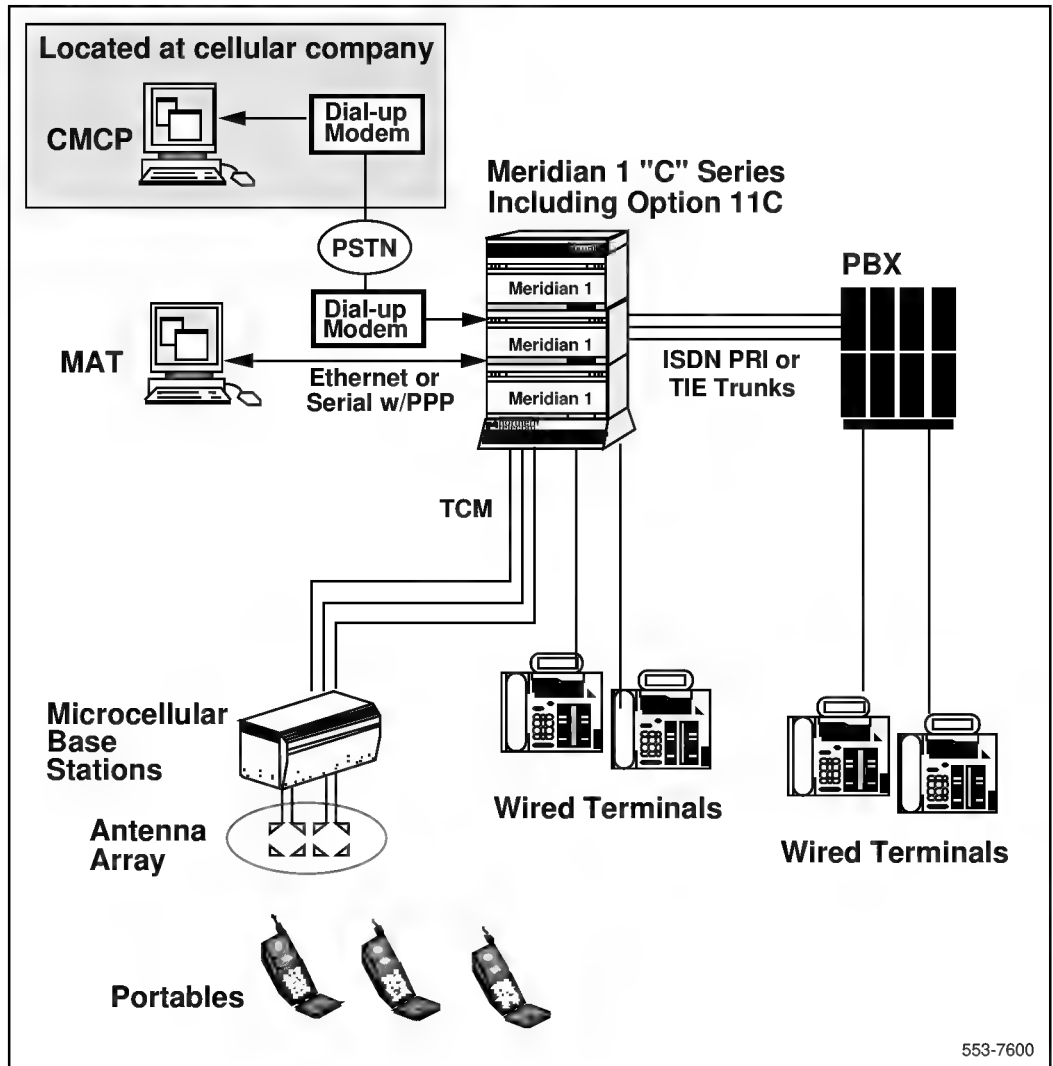


Figure 5
SL-1, SL-100, or third-party PBX connectivity



Key features and benefits

A summary of the key Microcellular features and their benefits follows. For additional detail about Microcellular features and supported Meridian 1 system and set features, see “Product features” on page 17.

Single handset: One standard cellular portable for use both in-building and in the wide area cellular network minimizes handset investment.

Voice Quality: EFRC provides near wireline voice quality to the Microcellular system.

Twinning: The cellular portable and the wired set can be assigned the same Directory Number, allowing calls to be presented almost simultaneously to both devices. Call treatment preferences are preserved, and users can answer calls on either device.

Wireless Privacy: When the desk set is twinned with the portable, Privacy prevents a call answered on the portable from appearing on the desk set.

One Number Call Delivery: A mobile user can publish only an office directory number (DN) and still be reached whether the user is in-building or off-site.

Cellular spectrum reuse: Use of licensed spectrum eliminates interference concerns.

High capacity: Supports up to 3,000 users per system.

Large coverage: The system can cover large sites or campus environments. It can also support high-density applications.

Automatic Frequency Planning: With the radio data received from the AFP Station, the AFP algorithm selects a valid set of initial voice channels for the system to use. During operation, it monitors the allocated frequencies and replaces them if there is a decline in signal quality.

Ease of expansion: Capacity can be increased by adding radios to the Base Stations and additional IPE circuit packs, if necessary.

Security: Microcellular uses Time Division Multiple Access (TDMA) digital technology to provide the in-building service. TDMA makes it extremely difficult to eavesdrop on conversations.

Data capabilities: Microcellular offers 9,600 baud data-transfer capabilities for applications such as fax and e-mail.

Multi-site roaming: Users can roam among Meridian 1 systems connected via a Primary Rate Interface (PRI) through use of the Mobility Multi-Site Networking feature package.

Access to popular PBX features: Meridian 1 integration offers cellular portable users Message Waiting Indication, CLID, call transfer, 3-party conference, and so on, while operating within the Microcellular system's coverage area.

Product features

Since Microcellular provides both in-building and wide-area mobility with a single handset, users are able to make and receive important calls while moving freely around their facility or off their premises. While inside their building, users have access to a number of popular Meridian 1 set features as well as the Meridian 1 system's call-processing capabilities. In addition, the Microcellular product works with the Meridian 1 system to provide capabilities specifically required for wireless communications (for example, handoff, roaming, and portable registration). Supported system features and set features are discussed in this section.

Mobility-specific system capabilities

The Microcellular system works in conjunction with the Meridian 1 system to provide the following features specifically required for wireless communications:

- **Portable registration**

Through this process, the system checks to ensure that a portable is properly registered on the system before providing service.

- **Basic call setup and teardown**

The system performs both call setup and teardown for incoming and outgoing calls.

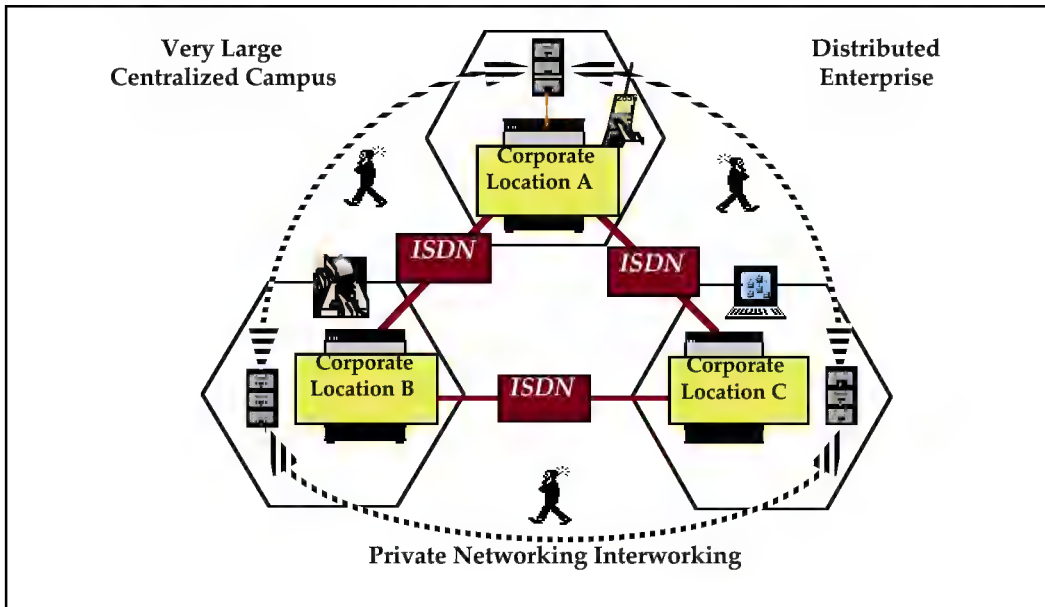
— **Handoff**

The Microcellular product automatically transfers active calls from one channel to another when required. Handoff within a single cell (to maintain call quality), between different cells (intrazone handoff), and between different zones (interzone handoff) is supported.

— **Multi-Site Networking**

With the Multi-Site Networking option, users can roam among Meridian 1 systems connected via a Primary Rate Interface (PRI) through use of the Mobility Multi-Site Networking feature package (see Figure 6). When a user roams to a visited system, the Meridian 1 system automatically identifies the portable and its home location by using a centralized database located at one of the Meridian 1 systems in the network. Calls to the user's home directory number (DN) are then forwarded, via the Meridian 1 network, to a temporary DN established on the visited system. Unanswered calls receive the treatment specified for the user's home DN.

Figure 6
Multi-Site Networking



Meridian 1 system and set features

Microcellular users also can take advantage of the following Meridian 1 system and set features while in-building:

- Access Restrictions
- Access to Paging
- Access to Recorded Telephone Dictation
- Attendant Features
 - Attendant End-to-End Signaling
 - Automatic Timed Reminders
 - Busy Lamp Field
 - Splitting
- Call Detail Recording (CDR) / CDR on Redirected Calls
- Call Forward All Calls
- Call Forward Busy
- Call Forward External
- Call Forward No Answer
- Calling Line Identification (CLID)
- Calling Party Name Display (CPND) (see *Note*)
- Call Park / Call Park Networkwide
- Call Redirection Service (see *Note*)
- Call Redirection by Time Of Day
- Call Transfer (see *Note*)
- Call Waiting
- Call Waiting Redirection
- Conference (3-party) (see *Note*)
- Direct Inward System Access (DISA)
- Directory Number Expansion

- Direct Private Network Access
- Electronic Switched Network (ESN)
 - End-to-End Signaling
 - ESN Uniform Dialing Plan
 - Network Alternate Route Selection (NARS)
 - Network Call Transfer (see *Note*)
 - Network Class of Service
 - Network Control Signaling
- Hunting (see *Note*)
- Intercept (see *Note*)
- ISDN Primary Rate Interface
 - Basic Call, North America ISDN PRA Connectivity
 - Call Redirection Service (see *Note*)
 - CLID
 - Network Call Party Name Display (see *Note*)
- Messaging Centers
 - IVMS/IMS
 - Meridian Mail
 - Message Waiting Center (see *Note*)
- Message Waiting Indication
- Multiple Appearance Directory Number (MADN) (see *Note*)
- Multi-Customer
- Music / Enhanced Music
 - Network Message Services
 - Meridian Mail
 - Message Centers (see *Note*)
 - Night Service / Trunk Answer from Any Station

(TAFAS) (see *Note*)

Trunk Route Optimization Before Answer

- One Number Call Delivery (see *Note*)
- Pretranslation
- Recorded Announcement
- Recorded Announcement for Calls Diverted to External Trunks
- Secretarial Filtering
- Speed Call / System Speed Call (see *Note*)
- Timed Forced Disconnect
- Trunk Anti-Tromboning
- User Selectable Call Redirection (see *Note*)
- Wireless Privacy

Note: This feature operates differently in conjunction with a portable set than with wired sets. In some cases, certain limitations apply to use with a portable. For a detailed explanation of the operation of all Microcellular features, see the *Nortel COMPANION Microcellular Operations, administration, and maintenance guide* (553-3611-300). For information about feature operation and support for the Multi-Site Networking option, see *Nortel COMPANION Microcellular Multi-Site Networking Description, operations, and administration* (553-3611-110).

When Microcellular's Multi-Site Networking option is used, certain features are not available; others work differently in a multi-site configuration than they do in a single site application. If not listed in the following section, features are supported and work as indicated in the previous list.

The following features either work differently or have certain limitations when used in conjunction with Multi-Site Networking:

- Calling Line Identification (CLID)
- Call Park / Call Park Networkwide
- Call Transfer
- Electronic Switched Network (ESN)
 Network Call Transfer
- Intercept
- Network Message Services
 Network Meridian Mail
- System Speed Call

For more information on feature operation, see *Nortel COMPANION Microcellular Multi-Site Networking Description, operations, and administration* (553-3611-110).

The following features are not supported in conjunction with Multi-Site Networking:

- Attendant Features
 Automatic Timed Reminders
- Call Forward Busy
- Call Forward No Answer
- Message Waiting Indication
- Multiple Appearance Directory Number (MADN)

System components and configuration

This section describes Microcellular software and hardware components and Microcellular system configuration. The configuration description includes lists of software requirements, hardware requirements, and system capacity and coverage.

Software and hardware components

A Microcellular system requires the following major software and hardware components. Additional components, such as connectors and cables, are listed and described in the site planning and deployment and installation documents.

Meridian 1 systems: The Microcellular product is supported on Meridian 1 Options 11C, 51C, 61C, 81, and 81C running X11 Release 23 or later software.

Mobility and Meridian 1 core software: Provides call control features and manages the operation of the Microcellular system.

Meridian Administration Tool (MAT): The Microcellular system is administered via the Mobility System Management application, which runs under MAT Release 5.

Multi-Purpose ISDN Signaling Processor (MISP): Routes messages between the Meridian 1 CPU and the Embedded Intelligent Mobility Controller (EIMC). The MISP is not required on Option 11C machines. A dedicated MISP is required on Options 51C, 61C, 81, and 81C.

Embedded Intelligent Mobility Controller (EIMC): Controls all call processing, portable location, and handoff activities for those portables in its domain (a zone). The EIMC also handles signaling among itself, the MISP and the Microcellular Transcoder Cards (MXCs). The EIMC resides in an IPE shelf.

Microcellular Transcoder Card (MXC): Provides the voice transcoding function for the Microcellular system. The MXC resides in an IPE shelf and connects to the Microcellular Base Stations via a twisted-pair interface. It may be configured as EFRC or VSELP.

Microcellular Base Station (MBS): Each MBS contains up to four TRU-II radios. (If the system is configured for EFRC operation, each MBS can support up to three traffic radios and one control channel radio.) The MBS can be placed at various locations within the customer's building, up to 3,000 feet away from the Meridian 1 system. All radio channels can be simulcast onto all antennas within the same cell to cover high-density areas economically.

TRU-IIs (radios): Each TRU-II supports one control channel or one TDMA voice channel. One control-channel radio and one voice-channel radio is always required in each cell. Additional voice channels can be added as needed to increase capacity. One TDMA voice channel can carry up to three simultaneous conversations.

Distributed antenna system (includes antennas, hybrids, and coaxial cable): Either directional or omnidirectional antennas can be used. Antennas are placed throughout the site and connected to the MBSs by standard coaxial cable. An optional hybrid (splitter/combiner) can be used to connect up to 16 antennas and up to four MBSs within a single cell.

Automatic Frequency Planning (AFP) Station: One or more AFP Stations monitor the surrounding RF environment and select channels to be used by the Microcellular system. AFP reduces installation and long term maintenance efforts.

Cellular portables: Industry standard, dual-mode AMPS/TDMA portables supporting either IS-136 or IS-54B standards are supported.

Connection to a Cellco Mobility Control Point (CMCP): A Meridian 1 system equipped with the Microcellular option must provide a dial-up connection to the CMCP, which is a PC-based tool that enables the local cellular service provider to maintain control of the cellular channels used by the Microcellular system. The CMCP resides at the cellular service provider's premises.

System configuration

Proper configuration of a Microcellular system requires knowledge of the customer's application and the specific characteristics of the site, which are determined during the site survey. The following sections highlight specific system-configuration requirements and limitations to provide a general overview of the system's capacity.

Detailed information on each item listed and information on additional cables and connectors is in the *Nortel COMPANION Microcellular Site planning and deployment guide* (553-3611-105) and the *Nortel COMPANION Microcellular Installation guide* (553-3611-200).

Software requirements

The Microcellular system requires X11 release 23 or later software with the following feature packages for Option 51C, 61C, 81, or 81C:

- SW000JX11R23 Base Software
 - BRI (216)
 - Phantom TN (254)*
- SW0500A Mobility Microcellular Software
 - MOSR (302)
 - MMO (303)

* Included in X11 release 23 base software

— Mobility System Management

- Alarm_Filter (243)*
- LAPW (164)*
- MULI (242)*
- MAT (296)*

Note: Alarm Filter (Option 243) is an optional package required only if the alarm filtering function is desired.

The following feature packages are required for an Option 11C X11 release 23 system:

— NTSF8020 Option 11 X11 release 23 Software—General Business

- Phantom TN (254)**

— NTSF8601 Mobility Microcellular Software

- MOSR (302)
- MMO (303)

— Mobility System Management

- Alarm_Filter (243)**
- LAPW (164)**
- MULI (242)**
- MAT (296)**

Note: Alarm Filter (Option 243) is an optional package required only if the alarm filtering function is desired.

* Included in X11 release 23 base software

** Included in NTSF8020

Multi-Site Networking requires the following software:

- NTSF8022 Option 11C Enterprise Software Package
- MMSN (314)
- ISDN (145)*
- PRA (146) (1.5 Mbytes)*
- ISL (147)*
- Ntwk_Srv (148)*
- NARS (58) or CDP (59)*

* Included in NTSF8022

Hardware requirements

The Microcellular product can be used with a Meridian 1 Option 11C, 51C, 61C, 81 or 81C system. At a minimum, a Microcellular system must be equipped with the following hardware:

- 1 MISP, if Option 51C-81C
- 1 EIMC
- 1 MXC
- 1 MBS with 2 TRU-IIs (1 control-channel radio and 1 voice-channel radio)
- 1 antenna connected to the MBS via coaxial cable
- 1 AFP Station connected to a local MAT
- 1 portable
- Required cables and connectors

Larger Microcellular systems must conform to the following configuration rules and limitations.

For Options 51C, 61C, 81, and 81C:

- Maximum of 3 EIMC cards in Option 51C, 7 in Option 61C, and 8 in Option 81 or 81C
- Maximum of 1 EIMC card per IPE shelf
- Maximum of 15 MXCs per EIMC (maximum of 12 MXCs per superloop)
- Maximum of 1 MBS per MXC (for EFRC)
- Maximum of 2 MBSs per MXC (for VSELP, see *Note*)
- Maximum of 4 TRU-IIs per MBS (see *Note*)
- Minimum of 2 TRU-IIs in each cell (1 control-channel radio and 1 voice-channel radio)
- Maximum of 1 control-channel radio plus a maximum of 3 traffic-channel radios (TDMA-3 voice and AMPS data) per MXC for EFRC

- Maximum of 1 control-channel radio plus a maximum of 7 traffic-channel radios (TDMA-3 voice and AMPS data) per MXC for VSELP
- Maximum of 4 MBSs per cell
- Maximum of 16 antennas per cell using 2 Dual 8-Port Hybrids
- Minimum of 1 and maximum of 12 AFP Stations

For Option 11C:

- Maximum of 1 EIMC card
- Maximum of 15 MXCs per EIMC
- Maximum of 1 MBS per MXC (for EFRC)
- Maximum of 2 MBSs per MXC (for VSELP, see *Note*)
- Maximum of 4 TRU-IIs per MBS (see *Note*)
- Minimum of 2 TRU-IIs in each cell (1 control-channel radio and 1 voice-channel radio)
- Maximum of 4 MBSs per cell
- Maximum of 16 antennas per cell using 2 Dual 8-Port Hybrids
- Minimum of 1 and maximum of 12 AFP Stations

Note: In a VSELP configuration, each MXC can support two fully loaded MBSs (that is, 8 TRU-IIs) as long as one of the TRU-IIs is a control-channel radio. Thus, two MXCs can support up to four MBSs in a single cell equipped with one control channel radio and fifteen voice-channel radios. If a 16th voice-channel radio is required in that cell, a third MXC must be added, or the cell must be divided. In an EFRC configuration, each MXC can support one MBS which can contain a maximum of three traffic-channel radios and one control channel radio.

System capacity and coverage

The actual capacity and coverage of a particular Microcellular system will depend on the number of users, the traffic requirements, the existing usage of the Meridian 1 system, the characteristics of the building in which the system is deployed, and the surrounding macrocellular environment. The following guidelines are general recommendations. Specific results in a particular application might differ greatly from these guidelines.

The following guidelines apply to the capacity of a Microcellular system:

A maximum of 500 Microcellular users can be supported on an Option 11C system, 1500 users on an Option 51C or 61C system, and 5,000 users on an Option 81 or 81C system.

Note: These are general limitations only. The actual number of users that can be supported by a particular Meridian 1 system can be determined only after proper system engineering has been completed.

The number of simultaneous calls in a Microcellular system depends on whether each call uses TDMA-3 voice or AMPS data and on the MXC configuration. The ACELP configuration, with VSELP default, handles up to nine simultaneous calls per MXC. In this case, each MXC can support up to three traffic-channel radios and one control-channel radio. The VSELP-only configuration supports up to 21 simultaneous calls and eight radios.

A single TDMA-3 voice channel supports three simultaneous conversations. Therefore, assuming 2% blocking and an average call length of 2.5 minutes, a single TDMA-3 voice channel supports 14 users within a cell. Two channels can support 54 users, and three channels can support 104 users. Assuming only 1% blocking and an average call length of 2.5 minutes, one TDMA-3 channel supports 10 users in a single cell, two voice channels can support 46 users, and three voice channels can support 91 users.

The following guidelines provide a general idea of the area that can be covered by a Microcellular system:

Each MBS must be located within 3,000 feet of the Meridian 1 system.

An MBS cannot be used to cover more than one cell.

The length of coaxial cable connecting each antenna to an MBS should not exceed 300 feet, in most cases.

A single directional antenna can cover up to about 300 linear feet, or an area of about 20,000 square feet, if no obstructions are in its signal path.

Assuming an optimal building design and environment, a cell composed of 16 antennas could cover approximately 300,000 square feet.

The maximum number of cells that can be supported on a single Microcellular system depends upon the building layout, its physical construction, and restrictions on antenna and coaxial cable placement.

One AFP Station covers approximately 100,000 square feet assuming an ideal RF environment.

Planning, Installing, and Operating a Microcellular system

Planning, installing, and operating Microcellular system requires the following activities:

- Site planning and deployment
- Installation
- Operations, administration, and maintenance

Site planning and deployment

This step involves evaluating traffic and site conditions to determine (a) the placement of Microcellular Base Stations, antennas, and coaxial cable, and AFP Stations to achieve optimal site coverage, and (b) the Microcellular-specific Meridian 1 hardware and software requirements. During this step, the number of cellular channels required will also be determined. The site planner should give the local cellular service provider a copy of the site's deployment plan and ask the cellular operator to provide the required channels. In most cases, the cellular service provider will also provide the required portables.

Note: Although a budgetary system configuration can be developed without use of any cellular channels, generating the final site deployment plan requires access to some frequencies for a short period of time. Thus, the local cellular service provider must approve this frequency access prior to the start of the final deployment planning activity on the site.

Installation

This step covers installing the coaxial cables, antennas, Microcellular Base Stations (MBS), TRU-II Radios, AFP Stations, Embedded Intelligent Mobility Controller (EIMC) cards, Microcellular Transcoder (MXC) cards, and, if required, a Multi-Purpose ISDN Signaling Processor card (MISP). Installation also covers configuration of the Microcellular system using Mobility System Management software on a Meridian Administration Tool (MAT). X11 Release 23 software with the appropriate Microcellular options must also be installed. Portables will usually be provided by the cellular service provider, but they must be programmed with information specific to each individual Microcellular installation. Finally, before the Microcellular system can be tested, the cellular operator must download the assigned cellular channels from the Cellco Mobility Control Point (CMCP) to the Meridian 1 system.

After installation and configuration of all system components, the RF subsystem should be tested again and adjusted, if necessary.

Operations, administration, and maintenance

Operations, administration, and maintenance encompasses using, maintaining, and troubleshooting the Microcellular system.

Documentation

The following documents cover the activities for planning, installing, and operating a Microcellular system in detail:

- *Nortel COMPANION Microcellular Site planning and deployment guide* (553-3611-105) provides deployment information that helps determine how many Base Stations, antennas, radios, and AFP Stations are required and where they should be placed.
- *Nortel COMPANION Microcellular Installation guide* (553-3611-200) details the procedures for installing and configuring system components.
- *Nortel COMPANION Microcellular operations, administration, and maintenance guide* (553-3611-300) details the procedures for operating a Microcellular system, including high-level maintenance information.

- *Nortel COMPANION Microcellular Feature card* (P0841607) details the features available on the handset and explains how to use them.
- *Nortel COMPANION Microcellular Multi-Site Networking Description, operations, and administration* (553-3611-110) describes the Multi-Site Networking option and explains how to operate and administer it.

Information on installation and operation of Meridian software, IPE and Network cards, and other standard Meridian 1 components used in the Microcellular system is in the documentation provided for those components. On-line help is also available for MAT.

Meridian 1
Nortel COMPANION
Microcellular
Overview

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